

Remarks on the morphology and habitat of *Glacies belzebuth* (Praviel, 1938) (Geometridae)

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Summary. On the basis of recent captures of *Glacies belzebuth* (Praviel, 1938) in the Cottian Alps (Italy), the external habitus of this geometrid moth is redescribed and detailed illustrations of the genitalia of both sexes are provided. Genitalia structures are compared with the taxonomically closest species-group taxa within the genus *Glacies* Millière. Brief remarks about habitat associations and phenology are also given. It is concluded that, contrary to views proposed in the literature during the past 50 years, *G. belzebuth* is a distinct species and neither a subspecies of *G. noricana* nor *G. bentelii*. The new records of *G. belzebuth* are the first from Italy.

Zusammenfassung. *Glacies belzebuth* (Praviel, 1938) wurde erstmalig in den Cottischen Alpen und damit neu für die Fauna Italiens nachgewiesen. Auf der Grundlage der Belegexemplare wird der Habitus der seit der Originalbeschreibung nur selten beobachteten Art nochmalig beschrieben. Die äußeren Genitalarmaturen beider Geschlechter werden beschrieben, abgebildet und im Vergleich mit verwandten Artengruppen-Taxa der Gattung *Glacies* Millière diskutiert. Habitatbindung und Phänologie der italienischen Population werden kurz charakterisiert. Konstante morphologische Merkmale in Verbund mit Angaben zur bisher bekannten Verbreitung und Ökologie lassen den Schluß zu, daß *G. belzebuth* eine distinkte Art darstellt und nicht als Unterart *G. noricana* oder *G. bentelii* zuzuordnen ist.

Résumé. À partir d'exemplaires de *Glacies belzebuth* (Praviel, 1938) capturés tout récemment dans les Alpes Cottiennes Italiennes, l'auteur présente une redescription de l'habitus de ce Géomètre, accompagnée d'illustrations détaillées de l'armure génitale des deux sexes. Ces dernières structures sont comparées à celles d'autres taxons du groupe-espèce les plus proches au sein du genre *Glacies* Millière. L'auteur fournit aussi quelques données relatives à l'habitat et à la phénologie du taxon en question. Contrairement à l'interprétation existante dans la littérature du demi siècle dernier, il arrive à la conclusion que *belzebuth* peut être considéré comme une espèce distincte et non comme sous-espèce de *G. noricana* ou de *G. bentelii*. *G. belzebuth* est signalé ici pour la première fois d'Italie.

Key words: Geometridae, *Glacies belzebuth*, *Psodos*, taxonomic status, Italy.

Introduction

Glacies belzebuth was originally described within the genus *Psodos* Treitschke by Praviel as a new species in 1938, the type locality being Mont Mounier (Alpes Maritimes, France). Although Praviel provided a figure of the male copulatory apparatus in the original description, *G. belzebuth* was considered in later works on the genus *Psodos* (s. lato) as a very problematical taxon. Its status as separate species has been systematically questioned.

Wehrli (1953) treated *belzebuth* in a section independent from both *noricana* Wagner, 1898, and *bentelii* Rätzer, 1890, pointing out the differences also with respect to *alpmaritima* Wehrli, 1924 (currently treated as a subspecies of *bentelii*: Scoble 1999), especially regarding the habitat and the corresponding geological substrate. Nonetheless, in the final part of his treatment, Wehrli stated that owing to the variability of the genitalia in *G. bentelii* and considering that *alpmaritima* shows a great polymorphism, *belzebuth* may be regarded as a subspecies of *bentelii*, which, using the words of Wehrli, 'has not left the species [*bentelii*] nearly so strongly as ssp. *panticosea* Wehrli' (*panticosea* Wehrli, 1945 is currently also regarded as a subspecies of *bentelii*: Scoble

1999). With this unclear statement Wehrli seems to provisionally assess the three taxa *alpmaritima*, *belzebuth* and *panticosea* as subspecies of *bentelii*.

In their important monograph, Povolný & Moucha (1955) treated *G. belzebuth* in a rather superficial way. This may be explained by the fact that these authors had no specimens at their disposal to deal with which belonged to this taxon. Praviel himself unintentionally contributed to this situation of uncertainty by pointing out, in the original description, the close affinity of *G. belzebuth* to *G. noricana*, whilst in a previous work (Praviel 1937) *G. belzebuth* had been confused with *G. bentelii*.

Wolfsberger (1966) regarded *belzebuth* as a subspecies of *noricana*, however he did not give any reasons for this interpretation differing from Wehrli's view. Nevertheless Wolfsberger's interpretation has been maintained in all subsequent catalogues (see for example Müller 1996; Leraut 1997; Scoble 1999). Müller (1996), in particular, did not include *belzebuth* in his list, but indicated *G. noricana* as a component of the French fauna. This can only be explained by considering *belzebuth* as a subspecies of *noricana*. In fact, *G. noricana* 'sensu stricto' has not been reported from the Alps of France (if we exclude a quotation given by Praviel (1937), preceding the description of *belzebuth*, and that very likely referred to this latter entity), reaching its western distributional limit in the Lechtaler Alpen (Austria) (Tarmann 1984), about 400 km away from the type locality of *G. belzebuth*.

It must be stressed that the assignment of *belzebuth* as a subspecies or local form to either *noricana* or to *bentelii* is actually merely an expression of opinion. Thus far, no formal nomenclatural act on this regard has ever been published, and a critical reappraisal of morphological or other characters to solve this issue has not been undertaken.

I have not been able to ascertain whether the type material (22♂, 4♀) is still preserved in Praviel's collection, now at the National Museum of Natural History of Paris. However, Scoble (1999) reports as syntypes the 26 specimens already cited by Praviel in the original description. Moreover, in the original description, Praviel stated that the female genitalia of the three related species *bentelii*, *noricana* and *belzebuth* were to be treated in a later work, but this apparently never happened.

I recently discovered, on the Italian slopes of southern Cottian Alps, a population of *Glacies* whose general appearance is in full concordance with the figure and the description of *Glacies belzebuth* given by Praviel. Praviel's remarks about the habitat and morphology of *belzebuth* are so unequivocal that I feel safe to interpret this newly discovered population as belonging to this taxon, even without examination of the type material. Moreover, the site where the newly found population lives is geographically close to the type locality of *belzebuth* (only about 30 km apart). Since almost no further observations on *G. belzebuth* have been published since its original description, the aim of this contribution is to provide a detailed description of both the male and female copulatory apparatus and to report my observations about its habitat. Such information will be crucial for a better understanding of the taxonomic status and ecological characteristics of *G. belzebuth*.

Glacies belzebuth (Praviel, 1938)

Material examined. – 1♂, Italy, Southern Cottian Alps, Cima Fauniera, 2500 m, 21.vii.1999; 2♂, 1♀, idem., 27.vii.2000; 6♂, 31.vii.2000; 1♀, 10.viii.2000; 1♂, 19.vii.2001; 4♂, 23.vii.2001; all leg. and coll. M. Gianti. 3♂, Cima Fauniera, 2500 m, 31.vii.2000; leg. M. Gianti, coll. TLMF Innsbruck.

Italy, Southern Cottian Alps, Colle Valcavera, 2400 m, 1♂, 21.vii.1999; 2♂, 19.vii.2001; 2♂, 6.viii.2001, leg. and coll. M. Gianti

Genitalia examined. – *belzebuth*: 11♂ and 2♀ from Cima Fauniera and Colle Valcavera; preps. M. Gianti ns. MGH 37, MGH 85, MGH 89, MGH 90, MGH 96, MGH 97, MGH 185, MGH 207, MGH 208, MGH 209, MGH 210, MGH 211, MGH 212 (all preparations in author's collection); ♂, France, Basses Alpes, Digne, 1923, leg. E. Wehrli; prep. G. Dobler n. G620. – *noricana*: ♂, Austria, Styria, Hochschwab, 10.vii.1921, leg. Schwingschuss, prep. G. Dobler n. G237. ♂, Austria, Dachstein, 2.viii.1906, prep. G. Dobler n. G240. ♂, Austria, Tyrol, Innsbruck, 26.viii.1926, prep. M. Hreblay n. 1121. ♂, Wallisertal, Tyrol, 2000 m, 7.viii.1940, Nt.Nr.3977/1, prep. M. Hreblay n. 1333. ♂, Germany, Oberbayern, leg. H. Meinicke, prep. M. Hreblay n. 1159. – *bentelii*: ♂, Switzerland, Gornergrat, 25.vii.1920, leg. E. Wehrli, prep. M. Hreblay n. 1737. ♂, Italy, Trentino, Adamello, Rif. Madron. 2900 m, M.viii.1958, leg. K. Burmann, prep. G. Tarmann n. G54. ♂, Switzerland, Poschiavo Valley, Piz Campascio, 1.viii.1922, leg. E. Wehrli, prep. G. Dobler n. G316. ♂, Switzerland, way to Britannia Hütte, 2800 m, 26.vii.1941, leg. E. Wehrli, prep. G. Dobler n. G244. – *panticosea*: ♂, France, Pyrénées Orient., Arête Nord du Cantigou [possibly Canigou?], 31.vii.1.viii.1909, H. Powell, prep. G. Dobler n. G210. 4♂, France, Frontière espagnole du Pyrénées orient., Esquerdes de Routja, 23.vii.1909, leg. H. Powell, preps. G. Dobler ns. G212, G214, G216, G217. – *alpmaritimae*: ♂, Italy, Alp. maritimes, Cima Argentera, 30.vii.1923, leg. E. Wehrli, prep. G. Dobler n. G259. ♂, Italy, Mont Gelas, 20.vii.1923, leg. E. Wehrli, prep. G. Dobler n. G260. – *bentelii*?: ♂, Italy, Cima Argentera, 31.vii.1923, leg. E. Wehrli, prep. G. Dobler n. G255.

The preparation n. G54 (Tarmann) is preserved in the Tiroler Landesmuseum Ferdinandeum (TLMF, Innsbruck). All other preparations are found in the Wehrli collection, currently held at the Zoologisches Forschungsinstitut und Museum Alexander Koenig (ZFMK, Bonn).

Description. – *Glacies belzebuth* is a medium to small sized *Glacies* (average forewing length, males: 11.35 mm [n = 22], females: 10.25 mm [n = 2]) (Fig. 1). The ground colour is of a shade of greenish-grey on all the wings, giving rise to a golden reflectance under sunlight and proper angulations, better noticeable in some individuals than in others. The upper surface of the forewing shows two crossing lines of a darker shade, delimiting a discal band that encloses the small but well visible discal spot. The shape of the discal band is rather regular, the shrink in the sector delimited by the anal vein and the second cubital vein (respectively designated with A and CuA following Hausmann (2001), Fig. 45, p. 48) is generally less marked than in related species (e.g. *G. canaliculata* Hochenwarth, 1785). Upperside hind wings with a dark irregular line delimiting the disco-basal zone.

On the underside of the four wings (Fig. 2) a wide and distinctly lighter marginal band is clearly visible. Discal spots detectable also on this side.

The general habitus is similar to that of *G. noricana*, but *G. belzebuth* is distinctly smaller, being comparable in size to *G. burmanni* Tarmann, 1984. The average forewing length in *G. noricana* is 13.5 mm (n = 32) in males and 12.9 mm (n = 20) in females, whilst *G. bentelii* males measure 13.5 mm (n = 12) and females 11.9 mm (n = 2; all data from Tarmann (1984)).

Male genitalia. – The general structure of the copulatory apparatus suggests the allocation of *G. belzebuth* to the *Trepidina* group of species, formerly erected as a subgenus of *Psodos* by Povolný & Moucha (1955). The valva does not reveal any particular diagnostic character. The shape of the saccus is rather variable, in some cases the top is flat, in others rounded or quite pointed (Fig. 3). Aedeagus similar to

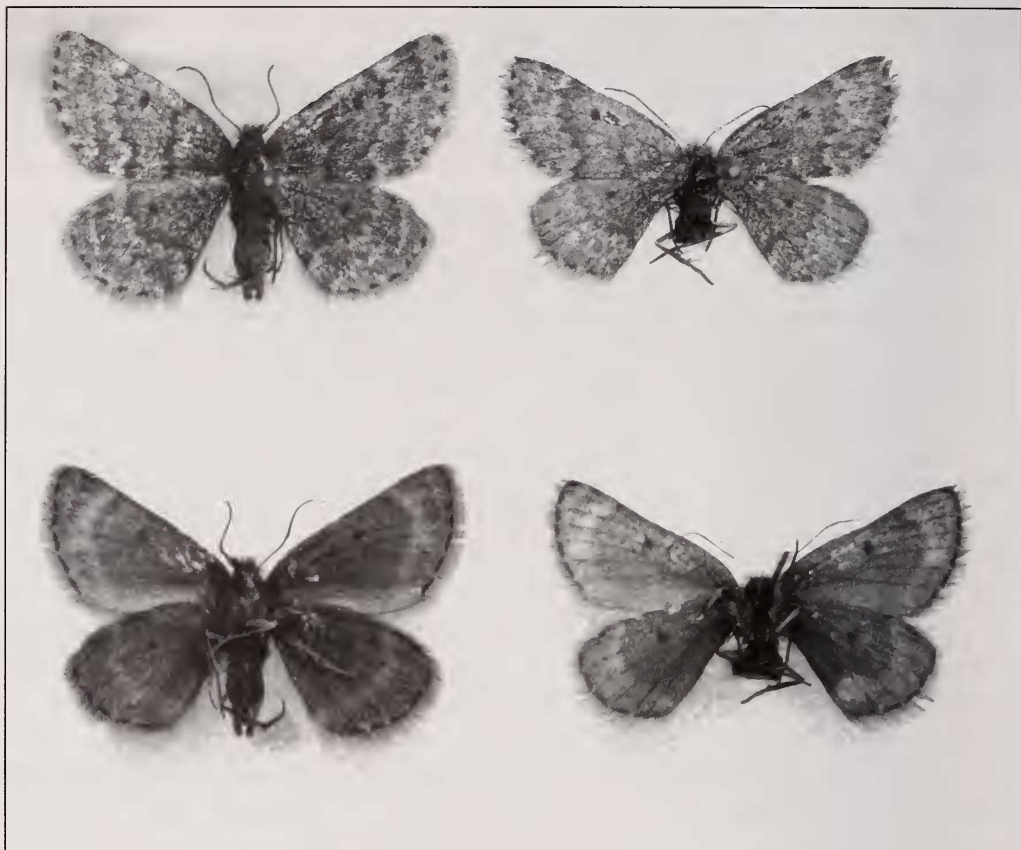


Fig. 1. *Glacies belzebuth*, dorsal view, ♂ (left) and ♀ (right). Italy, Cima Fauniera Argentera, 2500 m, 27.vii.2000. **Fig. 2.** *Glacies belzebuth*, ventral view, ♂ (left) and ♀ (right). Specimen data as in Fig. 1.

that of *G. noricana*, but the distal portion is comparatively longer and slender. In close proximity to the insertion of the ductus ejaculatorius, the proximal section forms an angle of approximately 120 degrees with the median portion, whilst in *bentelii* and *noricana* this angle is almost always wider, rising to about 180 degrees. This means that the proximal section and the median section of aedeagus are, in some specimens of these latter species, almost aligned (Fig. 4). In *belzebuth* the median portion is slightly concave on the upper side. Compared to *noricana* and *bentelii*, the spinosity of the apex is coarser in *belzebuth*. The form of the juxta ('innere Valven' sensu Wehrli 1921) is the most peculiar character of *G. belzebuth*. It is of the symmetrical type, even if the number, dimension and shape of the apical processes show a certain degree of variability. The distal portion, long and progressively slender, lacks the spined processes, except at the apex, whilst in the median portion, in proximity to the point in which it becomes narrower, a large and often curved tooth occurs (Fig. 5). The shape and position of this strong median tooth is clearly visible in the figure given by Praviel in the original description. As many authors have stressed, the structure of the juxta is of basic importance to discriminate between species of the genus *Glacies*. Even if a

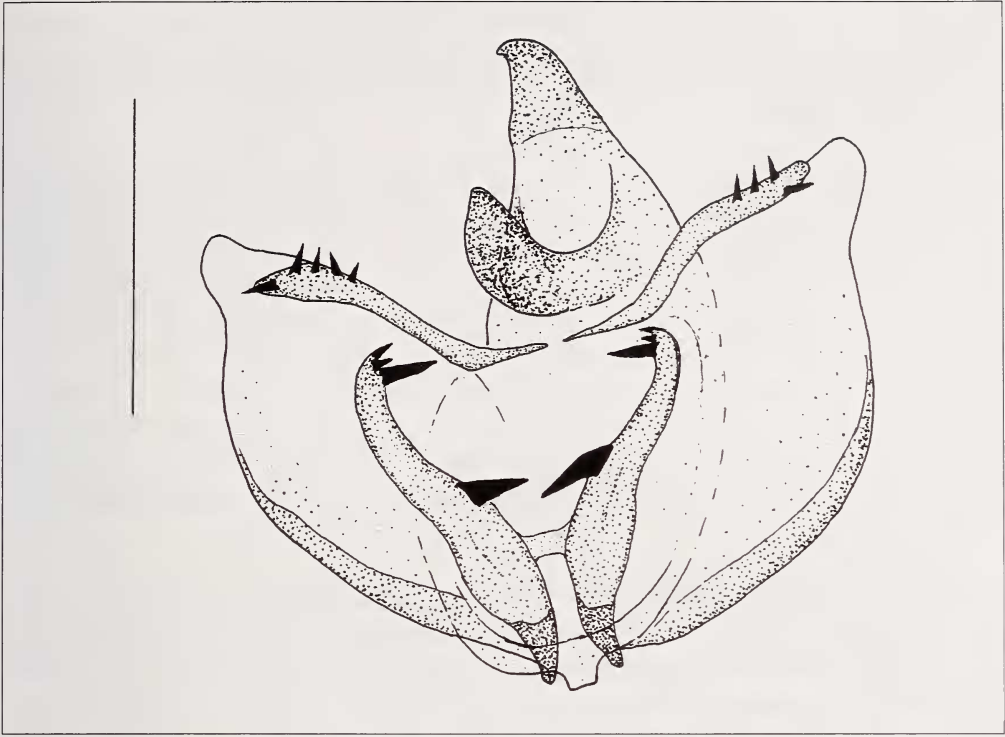


Fig. 3. *Glacies belzebuth*, ♂ genitalia (penis removed). Prep. MG H 90. Reference bar: 1 mm.

certain extent of intraspecific variability in the number and size of the spines is a rule, their arrangement, in addition to the shape of the juxta, are characters that are constant within the species. Eleven ♂ specimens of *G. belzebuth* have been dissected, and in all these the basic structure of the juxta proved to be constant. Especially the position, shape and size of the median tooth showed a great stability. Only in two specimens the left branch of the juxta lacks this strong process. The shape of the aedeagus also seems to be very constant within the population.

Comparative illustrations of the genitalia of other *Glacies* species (*Psodos* s. l.) are found in the works of Wehrli (1921), Povolný & Moucha (1955), Burmann & Tarmann (1983) and Tarmann (1984).

Female genitalia. – The general structure of the ♀ genitalia does not deviate from that of the other representatives of the *Trepidina* species group. However, some morphological characters are well defined, even if a greater number of specimens should have been analysed in order to evaluate the degree of stability, within the population, of these characters. The eighth sternite ('freier Analwulst' sensu Wehrli 1921) shows a more rounded profile than in the closest taxa. In particular, compared to *noricana*, the distal margin appears convex rather than concave, the centre of which bears the typical structure acting as a lodge for the uncus of the male ('Uncuslücke'). The form of the ostium bursae ('Vagina' sensu Wehrli) is similar to that of *noricana*. Bursa copulatrix globular, of regular shape, weakly sclerotized, as appears in all the representatives of

the genus. The most significant feature is found in the seventh sternite ('vorderer Haftwulst' sensu Wehrli), the centre of which shows a well marked wrinkle (Fig. 6), very similar to that observed in *G. burmanni*. This attribute is present in both examined specimens.

Distribution, habitat, phenology. – *Glacies belzebuth* is at present known from very few localities in the southwestern Alps. It seems to be confined to restricted areas of this alpine sector. Besides the type locality (Mont Mounier, Alpes Maritimes), Praviel (1938) recorded a specimen captured above Colmars (Basses Alpes). Both these localities, located within the French boundaries, are situated but 30–40 km away from the two Italian sites known today (spacing each other about 1 km only).

A specimen reputed by Praviel as belonging to the species *noricana* was collected on 12 July 1925 by Le Charles on the massif of Grande Chartreuse, about 150 km NW from Mont Mounier (Praviel 1937). This specimen could in reality belong to *belzebuth*, but at the time of its publication Praviel apparently had not yet recognized *belzebuth* as a distinct taxon.

The single examined genitalia preparation of *belzebuth* belonging to the Wehrli collection bears the label 'Digne', but this vague indication does not improve significantly the knowledge about the distribution of *belzebuth*. The corresponding specimen was probably collected by Wehrli himself since on the slide label the date '1923' is reported. In this same year Wehrli collected specimens of *alpmaritima* in the same alpine district (Maritime Alps).

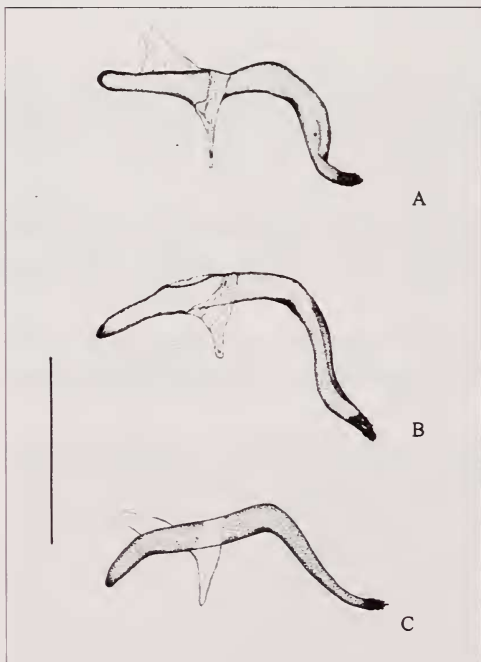


Fig. 4. Aedeagus: A – *Glacies bentelii* (after Tarmann 1984); B – *G. noricana* (after Tarmann 1984); C – *G. belzebuth*. Prep. MG H 89. Reference bar: 1 mm.

It cannot be excluded that in private collections, and perhaps also in public ones, further specimens of *belzebuth* may be present, confused amongst other species of the genus *Glacies*. In particular, confusion may arise with worn specimens of *G. canaliculata*. This species sometimes occurs in the same localities, although it usually inhabits a different biotope. While *canaliculata* occurs in areas covered with short grass, often interspersed by scattered rocks, *belzebuth* as well as *noricana* show a preference for areas almost free of vegetation, where the ground is bare to a great extent. Like *noricana*, *belzebuth* seems to occur exclusively on calcareous soil. *G. canaliculata* was reported by Povolný & Moucha (1955) as occurring on limestone soil in the Carpathian Mountains. This species also

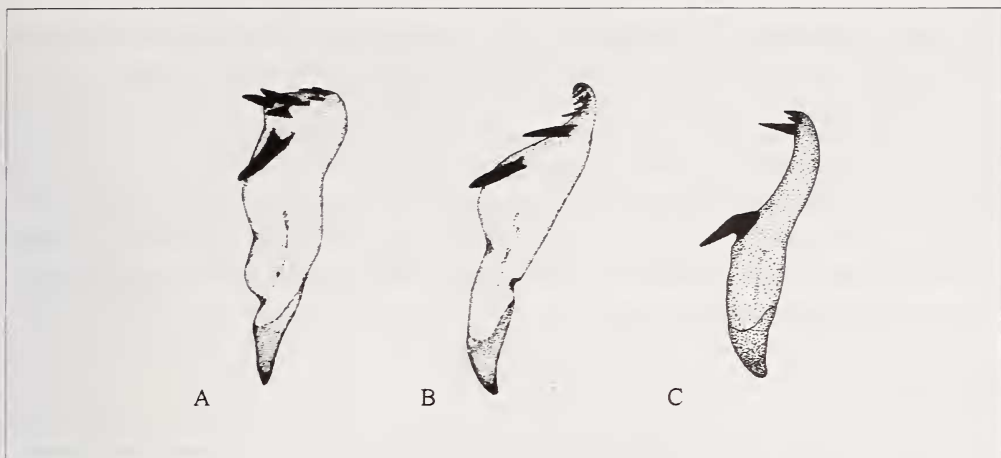


Fig. 5. Right branch of juxta: A - *G. bentelii* (after Tarmann 1984); B - *G. noricana* Wagner (after Tarmann 1984); C - *G. belzebuth*. Prep. MG H 90. Reference bar: 1 mm.

occurs on grassy areas around the sites inhabited by *belzebuth*, revealing a possible predilection for calcareous substrates. *G. bentelii* is reported to occur on Tonalit soil, whilst *G. burmanni* is known exclusively to occur on siliceous soils (Tarmann, *in litt.*).

All specimens of *belzebuth* were collected on south-facing slopes. The habitats seem to be restricted to very strongly wind-exposed areas with high erosive impact of rain and snow. The geological substrate appears to be rather unstable due to mechanical stress, being composed by formations with low cohesion characteristics.

Thus far it is unknown how widespread this type of habitat may be in the neighbouring mountainous districts around the known localities of *belzebuth*. Similarly an investigation for possible occurrences of *belzebuth* at other sites in the vicinity has not been undertaken until today.

The flora of the Italian localities is quite varied. Some of the most representative species or endemics (marked by *) of the Cottian Alps are: **Allium narcissiflorum* Vill., **Brassicella richerii* Schultz, *Astragalus australis* Lam., *Bupleurum petraeum* L., **Tulipa australis* Lk., **Pedicularis allionii* Rchb., **Achillea herba-rota* All. More typical of the calcareous gravel-ruins is *Elyna myosuroides* Fritsch. (all data from Mondino 1958). Within the habitat of *belzebuth*, *Leontopodium alpinum* Cass. is commonly found.

The vegetation of the site is reported by Bono & Barbero (1976) as belonging to the *Caricetum firmae* association. This association is often extremely fragmentary (i.e. interspersed among other vegetational formations) and represents one of the early stages of alpine plant colonization on wind-exposed calcareous substrates (Balletto *et al.* 1982).

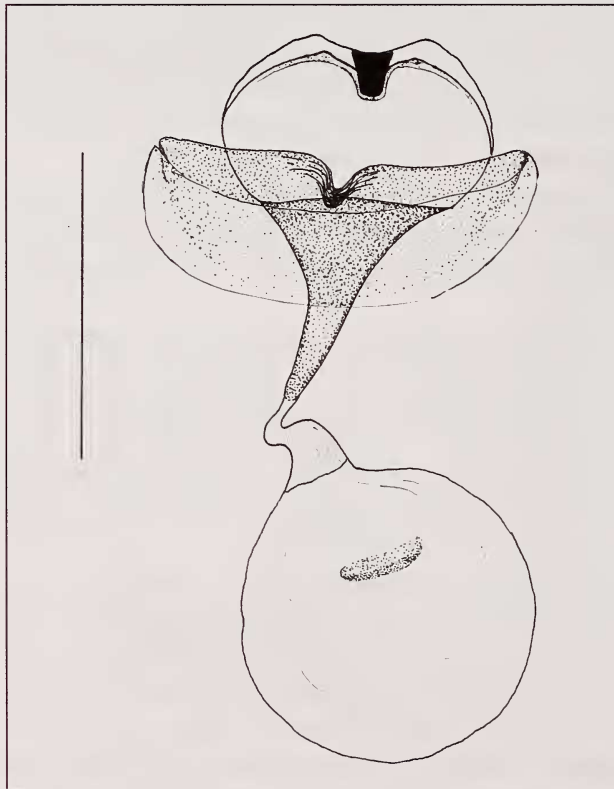
As already observed by Praviel, *belzebuth* inhabits the medium alpine zone. On the Massif du Mounier maximum abundance is observed around elevations of 2300 m, but the species is found down to 2100 m (as reported by Praviel himself in the original work). The population recently discovered on the Cima Fauniera (upper Grana Valley) and at Colle Valcavera lives at around 2400-2500 m.

The brief flight period of adults, deduced from the scarce data available today, ranges from the third decade of July to the first decade of August. All specimens were collected during daytime, especially in the morning, indicating diurnal activity as in other *Glacies* spp. They seem to start their activity very early (8–9 a.m.), but this strongly depends on the sunlight conditions, whilst in the afternoon fewer specimens have been observed. The moths frequently rest on the ground or on rocks, where they spread the wings presumably to bask in the sunlight. Their flight is often short and fast. Very few individuals were spotted to feed on flowers and rarely they fly off from rocky places. Larval food plants are not known.

Discussion

The taxonomic status of *belzebuth* (i.e., its relationships to the related taxa *bentelii*, *noricana*, *burmanni*, *alpmaritima* and *panticosea*) can only be definitively established by means of a thorough investigation of the entire genus *Glacies*. Nevertheless some points are worth discussion.

Examination of a number of genitalia preparations of *G. noricana* and *G. bentelii* from different localities, including the type localities, did not reveal any characters



that would induce me to affiliate *belzebuth* as subspecies with either *noricana* or *bentelii*. In all examined genitalia preparations of *bentelii* the structure of the juxta looks very strong, the distal end is wide and relatively flat, bearing a number of small teeth and few stronger teeth. The proximal tooth is of variable size, but always placed at about one third of the length of the juxta, measured from the apex. In *belzebuth*, in contrast, the presence of a large tooth placed approximately in the middle of the juxta is a constant feature, and the entire structure is more slender and less massive than in *bentelii*.

The examined preparations of *noricana* are characterized by the presence of numerous teeth,

Fig. 6. *Glacies belzebuth*, ♀ genitalia. Prep. MG H 85. Reference bar: 1 mm.

quite uniformly sized and distributed along the distal half of the juxtal branch. The corresponding part in *belzebuth* always lacks spines, and only the apex shows a large pointed process and a few smaller ones.

The taxon *panticosea* shows marked differences from all other related taxa. As compared to *belzebuth*, the juxta is shorter, wider and seems to be constantly distinguished by the presence of two large teeth arranged in a different way. The aedeagus is shorter, with very small apical spines.

Regarding the relationship between *belzebuth* and *alpmaritima*, more material of the latter would be necessary to compare. The two genitalia slides of *alpmaritima* that I have been able to examine look very different from the genitalia of *belzebuth*. Therefore, I have no reason to believe that what Praviel called *belzebuth* could belong to the same species of what he called, in the same work, *alpmaritima*. I concur with Praviel in recognizing *belzebuth* and *alpmaritima* as two morphologically different entities. Following the observations of Praviel (1938), *alpmaritima* lives at higher altitudes, being collected between 2800 and 3150 m on the Cima Argentera (type locality) and Monte Gelas, and very rarely at lower altitudes (2400–2500 m between the Pas des Ladres and Col de Fenestre, always on the massif of Gelas). Also the geological substrate of the habitats is different, being represented by calcareous formations for *belzebuth* and by gneiss for *alpmaritima*.

One examined genitalia preparation of a *Glacies* specimen from Wehrli's collection (prep. Dobler n. G255), labelled to be taken on the Cima Argentera, is very interesting. It looks similar to typical *bentelii* in both size of the apparatus and shape of the juxta, but is very different from the two preparations of *alpmaritima*. This suggests the need of a more thorough investigation of the populations from the Argentera massif, since the coexistence of *bentelii* and *alpmaritima* at the same locality would undermine the view of the latter being a subspecies of the former.

The stability of characters seen in the male genitalia of *belzebuth*, and the corresponding attributes of the females permit to diagnose *belzebuth* against all other related forms in a quite safely way, so it can be regarded as a distinct phenotype. Since genetic and breeding data are still lacking, the interpretation of *belzebuth* as a good species is thus far exclusively based on morphological evidence. Whether this entity is a distinct species in the biological sense (i.e. really showing reproductive isolation against all others) is a matter that remains to be solved.

On these grounds, I conclude that *belzebuth* should actually be accepted as a good species, occurring in allopatry to all related taxa currently assigned to the species *noricana* and *bentelii*. Considering *belzebuth* at specific rank does not imply any status change, since Praviel described it as a distinct species, and no formal rearrangement of its status by means of a nomenclatural act has successively been done.

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